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United States Department of Agriculture

BUREAU OF AGRICULTURAL ECONOMICS

SERVICE AND REGULATORY ANNOUNCEMENTS No. 133

THE OFFICIAL STANDARDS OF THE UNITED STATES FOR THE GRADING, SAMPLING, AND ANALYZING OF COTTONSEED SOLD OR OFFERED FOR SALE FOR CRUSHING PURPOSES

Effective, June, 1932

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FOREWORD

Within the last 50 years cottonseed has come from a farm waste to be a major source of income in the Cotton Belt. It is important, therefore, that producers be afforded the facilities essential to its effective marketing. Standard grades and methods of grading have long been recognized as a requisite to sound marketing methods of agricultural products generally. That they are also essential in the marketing of cottonseed is apparent from the fact that the oil content of different lots has been found to vary by more than 180 pounds and the protein content by more than 200 pounds per ton of seed, representing variations in value of more than 40 per cent. Seed values are further affected by spoilage, measures for which are needed.

Various efforts to find a method for satisfactory appraising and evaluating the content of cottonseed marketed for crushing purposes have been more or less continuous since cottonseed began to be important, but the variation both of quantity and condition of the constituents had presented obstacles to this attainment. In 1925 the Bureau of Agricultural Economics undertook, in response to requests from substantial factors in the industry and pursuant to its legal authority, to develop such a grading system. Through its Division of Cotton Marketing, studies of the nature and uses of cottonseed and of the grading requirements of the industry were made and a grading system based upon the chemical composition of seed was devised.

To complete the establishment of the standard grading method it was found necessary to perfect and standardize methods of chemical analysis. In December, 1928, a subproject headed by an inter-bureau committee was organized in cooperation with the Bureau of Chemistry and Soils to solve this phase of the problem. This committee has worked in close collaboration with the oil, fat, and wax laboratory of the Bureau of Chemistry and Soils, and practically all of the commercial and private laboratories interested in the analysis of cottonseed, the contributions of which are incorporated in the recommendations of the committee. The cooperation of the American Oil Chemists' Society is also acknowledged with appreciation.

NILS A. OLSEN,
Chief of Bureau.

ORDER OF PROMULGATION

PUBLIC NOTICE ESTABLISHING THE GRADES, METHODS OF SAMPLING, ANALYZING, AND GRADING COTTONSEED SOLD OR OFFERED FOR SALE FOR CRUSHING PURPOSES WITHIN THE UNITED STATES

By virtue of the authority vested in the Secretary of Agriculture by the act of Congress entitled "An act making appropriations for the Department of Agriculture for the fiscal year ending June 30, 1932, and for other purposes," approved February 23, 1931 (Public, No. 717, 71st Cong.), I, Arthur M. Hyde, Secretary of Agriculture, do hereby fix, establish, and promulgate the following standards of class, quality, and condition for cottonseed, which shall become the official standards of the United States for the grading and analysis of cottonseed sold or offered for sale for crushing purposes, on the 1st day of June, 1932, and be in force and effect as long as Congress shall provide the necessary authority therefor, unless amended or superseded by standards hereafter prescribed and promulgated under such authority.

SECTION 1. The grade of cottonseed shall be determined from the analysis of samples, and it shall be the result, stated as the nearest whole number without fractions, obtained by multiplying a quantity index by a quality index, as hereinafter provided.

(*a*) The basis grade of cottonseed shall be grade 100.

(*b*) High grades of cottonseed shall be those grades above 100.

(*c*) Low grades of cottonseed shall be those grades below 100.

SEC. 2. The following equations shall be used in determining the quantity index of cottonseed:

(*a*) For cottonseed, that by analysis contain not less than 17 per cent of oil, the quantity index shall equal 4 times the percentage of oil, plus 6 times the percentage of ammonia, plus 5.

(*b*) For cottonseed, that by analysis contain less than 17 per cent oil, the quantity index shall equal 5 times the percentage of oil, plus 6 times the percentage of ammonia, minus 12.

SEC. 3. The quality index of cottonseed shall be a percentage of purity and soundness, and shall be determined as follows:

(*a*) Superior quality cottonseed.—Cottonseed that, by analysis, contain less than one-half per cent foreign matter, and more than 8 per cent but less than 10 per cent moisture, and less than three-fourths per cent free fatty acids in the oil in the seed, shall be known as superior quality cottonseed and shall have a quality index of 102 per cent.

(*b*) Prime quality cottonseed.—Cottonseed that, by analysis, contain not more than 3 per cent foreign matter, not more than 12 per cent moisture, and not more than 1.8 per cent free fatty acids in the oil in the seed, shall be known as prime quality cottonseed and shall have a quality index of 100 per cent.

(*c*) Subquality cottonseed.—Cottonseed that, by analysis, contain foreign matter, moisture, and/or free fatty acids in the oil in the seed in excess of the percentages shown in section 3–b, or are seed from seed cotton that has been processed in a boll breaker, or other device for preparing snapped cotton or bollies for ginning, shall be known as sub-quality cottonseed; and the quality index of such cottonseed shall be found by reducing the quality index of prime quality cottonseed as follows:

(1) Not to exceed five-tenths of a unit for each 0.1 per cent of free fatty acids in the oil in the seed in excess of 1.8 per cent; provided that this reduction shall not exceed 50 units of the quality index of prime quality cottonseed.

(2) Not to exceed 1 unit for each 1 per cent of foreign matter in excess of 3 per cent.

(3) Not to exceed 1 unit for each 1 per cent of moisture in excess of 12 per cent.

(4) Not to exceed 8 units when the seed cotton has been processed as snapped cotton or bollies before ginning.

(*d*) Off quality cottonseed.—Cottonseed that have been treated by either mechanical or chemical process other than the usual cleaning, drying, and ginning (except such sterilization as may be required by the United States Department of Agriculture for quarantine purposes) or that are hot or fermented, or that upon analysis are found to contain more than 25 per cent foreign matter, or more than 25 per cent moisture, or more than 40 per cent combined moisture and foreign matter, shall be known as off quality cottonseed and may not be graded.

SEC. 4. Sampling of cottonseed.—In the application of these standards the following methods shall be observed in the drawing and handling of samples of cottonseed.

(*a*) Sampling before unloading.—Portions shall be drawn at different points in each end and in the middle of the car with a suitable cottonseed trier or sampling device. In drawing samples with a trier, cross sections shall be taken from the top to the bottom of the car, if possible. In the absence of a trier, holes shall be dug at various points at least 30 inches deep with a small (8-tine) fork and portions taken from the bottom and sides of these holes.

(*b*) Sampling during unloading.—For this purpose the sampler shall be provided with a suitable receptacle which he shall place in the center of the unloading chute at regular intervals, as the seed are being ejected from the car, to receive portions of the seed.

Whether drawn before or during unloading the several portions drawn from car lots shall total not less than 50 pounds in weight.

(*c*) Sampling of truck or wagon seed.—In drawing samples of truck or wagon loads of cottonseed, the same methods shall be used as in sampling car lots before unloading. The total weight of the portion drawn shall be not less than 2½ pounds for each ton of seed in the load.

(*d*) Handling samples.—Samplers shall be provided with metal containers with close-fitting covers large enough to hold 60 or 70 pounds of cottonseed. Each portion of a sample as drawn shall be immediately placed in such a receptacle and the cover promptly replaced. As soon as the full sample has been taken it shall be carefully weighed, then cleaned of foreign matter, and carefully reweighed. The loss in weight shall be calculated as foreign matter. After the sample is cleaned the seed shall be mixed either by means of a suitable mechanical mixer or by heaping together and mixing by passing the hands or a small shovel up through the heap, repiling and spreading by pressing. Finally not less than 2 quarts shall be packed in an air-tight tin can or Mason jar and sent to the laboratory for analysis and grading. All cleaning, mixing, and handling of samples shall be done expeditiously and without undue exposure.

SEC. 5. Analysis.—The methods for analyzing cottonseed recommended from time to time by the interbureau committee of this department on standard methods of sampling and analyzing cottonseed shall be used.

In testimony whereof I have hereunto set my hand and caused the official seal of the Department of Agriculture to be affixed in the City of Washington, this 23d day of May, 1932.

Arthur M. Hyde

Secretary.

METHODS OF ANALYSIS

RECOMMENDATIONS OF THE INTERBUREAU COMMITTEE ON STANDARD METHODS OF SAMPLING AND ANALYZING COTTONSEED

The interbureau committee on standard methods of sampling and analyzing cottonseed recommends the following methods for use in the analyzing of cottonseed:

1. *Laboratory sample.*—The portion of the sample of cottonseed received at the laboratory shall consist of approximately 1,000 grams (2¼ pounds) of cleaned seed and shall be known as the laboratory sample. It shall be received sealed in an air-tight container and shall be accompanied by a statement, certified by the sampler, giving the weight of the original sample and of the foreign matter separated by him.

2. *Determinations of percentage of foreign matter.*—The laboratory sample shall be examined immediately and if found not to have been thoroughly cleaned shall be carefully weighed and recleaned by use of a 6-mesh screen and by the hand picking of all remaining particles of foreign matter. The percentage of foreign matter shall be calculated by dividing the weight of the foreign matter reported by the sampler by the weight of the original sample and correcting the result by adding the percentage of foreign matter found in the laboratory sample.

3. *Mixing and quartering.*—The cleaned laboratory sample shall be mixed and quartered by either of the following methods:

(*a*) Place the sample in an approved mechanical mixer (MacLellan mixer No. 00–S) and mix by revolving 10 times at the rate of five revolutions a minute. After it is mixed, the sample shall be emptied on to a large piece of paper, and be pressed and quartered with a large spatula. Quadrants Nos. 1 and 3 shall be separated from quadrants Nos. 2 and 4. Quadrants Nos. 1 and 3 shall be immediately returned to the original container, shall be sealed, and retained as a referee sample. Quadrants Nos. 2 and 4 shall be preserved in an air-tight container for analysis. When they are finally used for analysis they shall be again placed on a piece of paper and requartered until the combining of opposite quadrants yields two samples of approximately 120 grams each. One of these shall be used for the determination of free fatty acids. The other shall be further quartered to yield two samples of approximately 60 grams each; one of these shall be used for the moisture determination and the other for oil and ammonia determinations.

(b) Mix and quarter the laboratory sample by passing the entire sample through the cottonseed sample divider, described in the Cotton Oil Press, Volume XIV, No. 5, September, 1930, page 31. A perfect mix can be accomplished by passing the entire sample through the divider two or three times. After mixing, one of the two portions resulting from the division, of approximately 500 grams each, shall be reserved as a referee sample. The second portion shall be again passed through the divider; one of the resulting two portions, of approximately 250 grams each, shall be reserved for emergency check analysis; the second portion shall be returned through the divider and one of the resulting portions, of approximately 125 grams each, shall be used for the determination of free fatty acids and the remaining portion, after again being divided, will yield two portions of approximately 62 grams each, one of which shall be used for the moisture determination and the other for the oil and ammonia determinations.

4. *Moisture determination of cottonseed.*—Moisture determination may be made by either of the following methods:

(*a*) Carefully crack each seed coat by means of an approved laboratory crimper. Weigh duplicate samples of about 5 grams each into aluminum dishes 2 inches in diameter and three-fourths inch high, fitted with covers. Dry for five hours at 101° C. in an American Oil Chemists' Society official jacketed oven or in a forced-draft circulatory oven of approved type. The oven shall not be opened during the drying period; if this is unavoidable, the actual time shall be extended sufficiently to offset any temporary cooling due to opening the oven. When the drying period is over the cover shall then be placed on the dish and the dish placed in an efficient desiccator until cool (one-half hour). The sample shall then be weighed, and the loss in weight shall be calculated as moisture.

[Note.—For use in cracking the seed coats an ordinary tinner's crimper, when properly adjusted, is approved. A more satisfactory cracker, which may be used also for hulling dried cottonseed for the separation of the kernels or meats, can be made by substituting steel rollers for the rubber-covered rollers of a clothes wringer, the lower roller being knurled and the upper roller grooved.]

(*b*) Weigh duplicate samples of about 5 grams each, of the whole uncracked seed, into shallow moisture dishes and distribute the seed evenly. The uncovered dishes containing the samples are placed in the oven specified in paragraph (*a*) at 101° C. for from 12 to 16 hours, or most conveniently, overnight. The dishes when removed from the oven are covered, cooled in an efficient desiccator (one-half hour) and weighed, the loss in weight being calculated as moisture.

5. *Preparation of seed for oil and ammonia determinations.*—Dry the approximately 60-gram portion, quartered out for the purpose, for two hours at 130° C.

± 3° in an approved type of forced-draft circulatory oven. When drying a few samples the De Khotinsky oven may be used. Absorb into the inner walls and bottom of a porous earthenware vessel (such as a 3-inch flowerpot) 1.5 c c of concentrated hydrochloric acid. The acid should be well distributed all over the side and bottom of the pot. When the acid has been absorbed, the pot should appear dry. If it does not, the pot was probably not in proper condition for this use.

Place the dried seed in the pot, cover the pot with a watch glass, and place it in a fuming oven (a well-ventilated noncorrosive oven capable of reaching and maintaining a temperature of 125° C. ± 5° at 125° for one hour. When the seed is fumed, the lint should be loose and brittle, but not scorched. Grind the sample in a Bauer mill (No. 148 laboratory mill with No. 6912 plate) which has been adjusted to produce a fine meal. After grinding, open the mill and carefully brush out all remaining ground seed onto a sizable sheet of smooth paper. There should be practically no loss of material in grinding.

Mix the ground sample thoroughly. It is recommended that this be done by placing the ground material in a ½-gallon Mason fruit jar, together with a large rubber stopper. Replace the cover and shake violently until the ground material is thoroughly mixed, then transfer to a well-stoppered bottle or container, of just sufficient size to hold the material tightly so as to prevent percolation or vertical segregation of the components.

6. *Moisture determination of ground sample.*—Weigh 5 grams of the fumed and ground sample into a moisture dish and dry at 101° C. for two hours in oven specified for moisture determination of cottonseed; calculate loss in weight as moisture content.

7. *Oil.*—(*a*) Apparatus and reagents. Extraction apparatus of Butt type. Allihn condensers with 12-inch jackets, fitted with cork connections, are recommended. Petrolic ether of the following specification:

Initial boiling temperature, not less than 35° C.
Initial boiling temperature, not over 40° C.
Dry-flask end point, not over 60° C.
Dry-flask end point, not less than 50° C.
At least 95 per cent distilling under 55° C.
Not over 85 per cent distilling under 40° C.
Specific gravity of 60° F., 0.630 to 0.675.
Color, water white.
Evaporation residue, not over 0.002 per cent by weight.
Doctor test, sweet.
Copper-strip corrosion test, noncorrosive.
Unsaturated compounds, trace only, permitted.

Distillation test shall be made according to American Society for Testing Materials standard method D86–27 for distillation test of gasoline; a blank must be made by evaporating 250 c c with about 0.25 gram of stearin or other hard fat (previously brought to constant weight by heating) and drying as in the actual determination. The blank must not exceed a few milligrams.

(*b*) Determination. Weigh accurately duplicate samples of 4 to 5 grams of the fumed and ground seed, spread each portion in a thin layer on a 150-mm filter paper (Reeve-Angel No. 211 or equivalent grade); fold paper at a point about one-quarter the distance from each of two opposite sides to the center over the sample; wrap by coiling from one of the unfolded sides into a cylinder; and rewrap in a second paper or papers in such manner as to prevent escape of the meal, leaving the top of the second paper open like a thimble. Place a piece of absorbent cotton in the top of the thimble to distribute the dropping ether. Place 25 c c of petrolic ether in a tared flask, 125 c c capacity, and extract sample for four hours. The ether should drop on the center of the thimble at a rate of at least 150 drops per minute. The volume of the solvent should be kept approximately constant. The solvent should then be evaporated off until no trace remains; the sample is then cooled to room temperature, and weighed. The last traces of ether are sometimes difficult to detect by odor. In case of doubt evaporate for an hour or longer until constant weight is obtained. Calculate the oil content as shown in the following example:

Petrolic ether extract	1.025 grams.
Original moisture 12.2 per cent plus total foreign matter up to and including 1.0 per cent	12.2+0.8=13.0
Second moisture	2.6

$$\frac{1.025}{5}\times\frac{87}{97.4}=18.3 \text{ per cent of oil}$$

8. *Ammonia determination.*—(*a*) Apparatus and reagents. Use Kjeldahl digestion flasks of 650 c c or 800 c c capacity, digestion rack for supporting flasks over burners, distillation stand with condensers, flasks for receiving the

ammonia distillate, metallic mercury or mercuric oxide, sodium or potassium sulphate, concentrated sulphuric acid, zinc (preferably granular 20 mesh), 4 per cent solution of potassium or sodium sulphide, and caustic soda solution (specific gravity 1.50).

(*b*) Digestion procedure. Digest 1.7034 grams[1] of the sample in a Kjeldahl flask with approximately 0.5 gram metallic mercury or 0.7 gram mercuric oxide, 10 grams of sodium or potassium sulphate, and 25 c c of sulphuric acid (specific gravity 1.84). Place the flask in an inclined position and heat below the boiling point of the acid from 5 to 15 minutes, or until frothing has ceased. Increase the temperature and continue digestion until the liquid becomes colorless, or until complete digestion is obtained. The process is the same from this point on as in the regular Kjeldahl method, except that no potassium permanganate is added.

(*c*) Distillation. After cooling, add about 300 c c of distilled water, a few granules of zinc to keep the contents of the flask from bumping, and 25 c c of a 4 per cent solution of potassium or sodium sulphide, or a sufficient quantity to precipitate all the mercury. After mixing thoroughly, add 60 c c of a caustic soda solution (specific gravity 1.50), or sufficient to make strongly alkaline, pouring the solution down the side of the flask so that it does not mix at once with the acid solution. Connect the flask with a condenser of block tin, mix the contents of the flask by shaking, and distill into an accurately measured quantity of standard sulphuric acid solution (0.5N recommended) to which has been added 50 c c of distilled water, until at least 200 c c of distillate is obtained, taking care that the delivery tube reaches below the level of the standard acid. Add about 1 c c of a 0.2 per cent aqueous solution of sodium alizarin sulphonate as the indicator. Either cochineal or methyl red may be used as the indicator, but with methyl red, the solution is titrated hot. Then titrate the distillate with a standard fixed alkali solution (a 0.25N sodium hydroxide solution is recommended).

(*d*) Blank correction. Make blank test on all reagents and correct the titration of the above distillate accordingly.

CALCULATION FOR AMMONIA

Example:

Quantity of 0.5N HCL measured into flask	10.00 c c
Quantity of 0.5N HCL for blank test on reagents	.06 c c
Quantity of 0.25N NaOH used in titration	2.68 c c

$$\frac{10-0.06}{2}-\frac{2.68}{4}=4.30 \text{ per cent ammonia in fumed seed.}$$

Original moisture	8.1
Moisture in fumed seed	2.0
Foreign matter, up to 1.0	.9

$$\frac{4.30\times 0.91}{0.98}=3.99 \text{ per cent ammonia in original seed.}$$

9. *Free fatty acids determination.*—Heat the portion of about 120 grams of the clean sample of seed for 30 to 40 minutes at a temperature of 100°–105° C.; then cool. Pass the cooled seed through an approved laboratory huller. Separate the meats from the hulls by the use of a 4 or 6 mesh screen. Any linty hulls that go through the screen can be removed by shaking the sample on a 15-mesh screen; the hulls will lump together and then can be removed easily. A complete separation of meats and hulls is essential (approximately 65 grams of meats should be obtained). Without undue loss of time, grind the meats in a Wiley mill through a 1.5-mm screen. Mix the ground meats on a large piece of paper and quarter so as to obtain a 30-gram sample. Extract this sample by cold percolation in the following manner: Place the lower disk from a Knorr extraction apparatus in a Butt tube and place on it a layer of asbestos fiber suspended in petrolic ether. A satisfactory mat should allow none of the meats to pass through, but should allow the extracting solvent to flow through at about 150 drops per minute. Place the sample in the prepared tube. Tap the tube several times so as to settle the sample to prevent later channeling by the solvent. Place a weighted extraction flask under the lower end of the supported tube and add 50 c c of petrolic ether, followed by two portions of 25 c c of petrolic ether, each portion being allowed to flow through before the

[1] By using the weight 1.7034 grams of sample for the analysis, the number of cubic centimeters of 0.5 normal acid required for the neutralization of the distilled ammonia, divided by 2, gives the percentage of ammonia.

following portion is added. Evaporate the ether from the oil on a steam bath. Remove the last traces of ether by placing the flask in an oven at 101° C. for one hour or longer if necessary. Weigh the oil, add 30 c c of neutralized alcohol, 10 c c petrolic ether, 1 c c of 1 per cent alcoholic solution of phenolphthalein and titrate the free fatty acids of the oil with standard alkali. (0.10 N alkali is used if free fatty acid is low, but 0.25 N is used for oils with free fatty acids above 3 per cent.) The titration is performed in a flask which is shaken vigorously during the titration, the end point being taken when a permanent pink is obtained which persists for at least one minute. Calculate as follows:

$$\frac{28.2 \times \text{normality of alkali} \times \text{cubic centimeters used}}{\text{weight of oil}} = \text{percentage of free fatty acids}$$

Interbureau committee on standard methods of sampling and analyzing cottonseed:

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June 30, 1932.

EXPLANATION AND APPLICATION OF THE OFFICIAL STANDARDS FOR THE GRADING, SAMPLING, AND ANALYZING OF COTTONSEED SOLD OR OFFERED FOR SALE FOR CRUSHING PURPOSES

By G. S. Meloy, *Bureau of Agricultural Economics*

So rapid has been the growth of the cottonseed crushing industry that more attention has been given to the methods of processing and the distribution of the products, than to the methods of purchasing and garnering the seed. The idea became prevalent that so far as the composition of the seed was concerned the same quantities of products could be obtained from any variety or growth and the products would be of the same prime quality, provided the seed had not deteriorated or been damaged.

DESIRABILITY OF GRADING RECOGNIZED

Some of the progressive cottonseed crushers, realizing that different lots of cottonseed varied widely in their composition, in about the year 1914, initiated steps with a view to establishing a method of grading. This work was abandoned about 1919, after a method of discounting the base price had been adopted. No basis grade was established, but it was assumed that the base price would represent the value of the average of the recoverable products. The discounts were based on immature seeds, on discolored kernels, and on moisture and foreign matter. Without a basis grade the local prices paid for cottonseed approached the value of the average quantity and quality of obtainable products as influenced by local conditions of growth, and effects of local storms, etc. No provision was made for premiums for seed better than the average nor for protection on purchases poorer than the local average.

By 1924 the industry realized that these rules of purchase were equitable neither to the crushers nor to the producers, and at the annual convention of the Interstate Cottonseed Crushers' Association held May, 1924, a resolution was passed requesting the United States Department of Agriculture to make a study of the subject with a view to establishing standardized grades for cottonseed. Studies were begun in July, 1925. Briefly, these studies developed the following facts: (1) That from a quantitative standpoint different lots of cottonseed varied widely in oil content, in protein content, in moisture content, in kernel content, and in residual fiber content, although value was usually based on the oil content alone; (2) that the method of measuring deterioration on the basis of the color of the kernels had no scientific basis and frequently resulted in gross injustices; (3) that the sampling and handling of samples were done by crude and inaccurate methods so that representative samples were rarely obtained; and (4) that the methods of chemical analysis varied between laboratories and that many of the methods in use were inaccurate.

The studies were, therefore, directed to: (1) The correlating of the variable ingredients of cottonseed so as to evaluate them quantitatively; (2) the accurate measurement of deterioration that may have taken place; (3) to the accurate sampling and the preservation of samples; and (4) the uniformity and accuracy of the methods of chemical analyses. The grades, the method of grading, the methods of sampling and analyzing, established by the order of the Secretary of Agriculture, signed May 23, 1932, are the results.

THE STANDARD BASIS GRADE

Under the method of determining the grade set up in these standards, many combinations of the ingredients of cottonseed are possible that will result in the base grade 100; but for purposes of price determinations this grade may be thought of as having the following basic analysis: 18.5 per cent oil; 3.50 per cent ammonia; and not to exceed 1.8 per cent free fatty acids in the oil in the seed, nor 3 per cent foreign matter, nor 12 per cent moisture. The quantity index of seed having such an analysis would be 100, the quality index 100 per cent, giving a grade of 100. Under standard crushing efficiency, a ton of cottonseed having such an analysis will yield 313 pounds of oil, 822 pounds of meal (41.13 per cent protein content), 125 pounds of linters, and between 625 and 645 pounds of hulls, depending upon the manufacturing and the moisture loss during the processing; all of these products being of prime quality. The price of cottonseed of the basis grade, therefore, should have a direct relation to the sale value of these quantities of products minus the costs of assembling, processing, and distribution, and profit.

QUANTITY INDEX

In the standard method of grading first a quantity index is found for the reason that the oil content of different lots of cottonseed varies in normal seasons from below 14 per cent to over 23 per cent, or by more than 180 pounds of oil to the ton of seed. Further, the protein content, measured in terms of ammonia, has been found to vary from below 2.80 per cent to above 4.80 per cent, which results in a difference of more than 470 pounds of meal of 41.13 per cent protein.

Some lots of cottonseed are found to be deficient in both oil and protein, other lots are found to be higher in both oil and protein than the average; but generally there is an inverse position of the content of oil and protein in the seed, so that seed that are extra high in oil content are usually deficient in protein, and seed found to be low in oil are usually found to have a high development of protein. The method of determining the quantity index provides for the offsetting of deficiencies in one of these ingredients by extra quantities of the other.

Based on the analysis of more than 45,000 shipments of cottonseed of the 1931–32 crop, representing approximately 1,250,000 tons, the different lots of seed varied in oil content from 14.50 to 23.10 per cent and the ammonia content from 2.78 to 4.87 per cent. The available oil obtainable under standard manufacturing processes varied from 230.0 to 410.0 pounds, and the meal or cake (41.13 per cent protein) from 653.8 pounds to 1,144.4 pounds. From the natural combinations of oil and ammonia found in the different lots of seed, the quantity index varied from 83.4 to 119.0

The quantity index of cottonseed is, therefore, an index of the relative quantities of products contained in different lots of cottonseed, the differences in these quantities being due to variety of seed and to cultural and climatic conditions during the growth and maturity of the fruit of the cotton plant.

QUALITY INDEX

The quality of cottonseed from the standpoint of the crusher is affected by those factors that increase the costs of processing, by the hazards of storage and processing, and by the quality of the obtainable products. Among these factors may be listed free fatty acids in the oil in the seed; excess moisture; foreign matter; heating in storage or transit; fermentation; frosting of immature bolls; crushed, cracked, or hulled seed; exposure to chemicals, etc.

The effects of some of these factors may be measured, but no means of accurately measuring either the immediate or the proximate effects of the other factors are known at this time.

The percentage of free fatty acids in the oil represents the extent that the oil has broken down or deteriorated. Deterioration in the oil is usually accompanied by deterioration in the quality of the other products, especially in the more progressive stages as indicated by free fatty acid contents above 3 per cent.

The moisture content of cottonseed has an important bearing on the recovery of oil as well as on the quality of all products and the keeping quality of the seed. Better extraction of oil is possible from seed with a moisture content between 8 and 10 per cent than from seed of any other moisture content. If cottonseed contain less than 8 per cent moisture, additional moisture must be incorporated before pressing, but difficulty in obtaining homogenous distribution of moisture increases as the normal moisture content decreases.

Cottonseed containing in excess of 12 per cent moisture will deteriorate in storage; the higher the moisture content, the more rapid the deterioration. This deterioration is frequently accompanied by a rise in temperature, even to the point of charring the seed. The excess moisture (above 12 per cent) must be removed before either crushing or storing, but the artificial drying of cottonseed in bulk is costly and is usually accompanied by unavoidable lowering of the quality of the products.

When the foreign matter is found in cottonseed it is there as a result of harvesting methods followed by incomplete cleaning during ginning, or as a result of direct adulteration. The presence of foreign matter increases the hazards of storage, reduces the efficiency of crushing, and lowers the quality of the products. The removal of foreign matter is costly and difficult. Complete removal from the seed is impossible if the moisture content of the seed is high.

SAMPLING COTTONSEED

The accuracy of the grade determinations of cottonseed depends, in the first place, upon the representativeness of the sample. Few handlers of cottonseed appreciate the difficulties of accurately sampling a lot of cottonseed. Practically every shipment of cottonseed is made up of portions of seed differing in oil content, in ammonia or protein content, in moisture content, in good seed and damaged seed, and in irregularly distributed foreign matter. Since all of these factors have a bearing on the grade, it is necessary that the sample that is drawn represent each factor in proportions equal to these factors as they occur in the whole shipment.

The difficulties of properly sampling a car lot of cottonseed before it is unloaded is increased if the car is heavily filled, and proper sampling is impracticable if the car is completely filled. More truly representative samples can be obtained if they are drawn during the unloading process, by the method prescribed in sections 4–6 of the order of the secretary.

A satisfactory receptacle for use when drawing samples during unloading may be construed by attaching an 8 by 5 by 5½ inch elevator bucket to the end of a pole. The pole or handle should be long enough to enable the sampler, while standing outside of the car, to place the bucket or receiving box in a level position near the top of the seed chute, to receive portions of the seed as they are being ejected. Such a bucket holds, approximiately, 2 pounds of seed, so it will be necessary to draw not less than 25 portions to obtain a full sample of 50 pounds; 30 or 40 portions should be drawn from heavily loaded cars.

HANDLING SAMPLES

A perfectly representative sample may be made misleading and worthless if it is not properly handled. The original sample must be thoroughly mixed and then quartered down to approximately 2¼ pounds. But cottonseed containing foreign matter can not be mixed. The rule, therefore, requires that the original sample first be cleaned and then be mixed. Cottonseed are peculiar in that ordinary stirring will cause a segregation rather than a mingling or blending of the various components of the lot.

Two kinds of mechanical mixers have been found satisfactory for mixing cottonseed. One form is a modification of a rotary-drum concrete mixer. After it has been cleaned, the sample should be placed in the drum and should be mixed according to the directions for the use of the machine, that is by turning at the rate of five turns a minute, making not less than 10 revolutions. After it is mixed, the sample is dumped and a 2-quart can is packed by taking handfuls at random from the pile.

A more satisfactory machine is a shaker apparatus which automatically cleans and reduces the sample. This machine cleans the sample over screens and draws off a cross-section portion through an adjustable side vent in the chute through which the cleaned seed escape. When using this machine the weight of the original sample is compared with the weight of the dirt and trash removed in order to calculate the percentage of foreign matter.

No satisfactory method has been devised, as yet, for drawing samples of cottonseed that is stored in large piles or bins.

AVERAGE GRADE OF CURRENT GINNINGS

Whenever it becomes advantageous to know the average grade of cottonseed of current ginnings, a sample should be drawn. For this purpose an automatic sampling device may be placed in the seed conveyor outside the gin house, or small portions of approximately 1 quart each may be taken from the seed from each bale as ginned. The portions as drawn should be placed in metal containers with tight-fitting covers. At the end of the day the full sample, so drawn, should be tested for foreign matter, and when cleaned the seed should be mixed and reduced to a 2¼-pound portion to be sent to the chemist for grading. The directions heretofore given for mixing samples of cottonseed should be followed carefully.

REPORTS OF ANALYSES

Reports of cottonseed analyses should give data on the following subjects expressed to the decimals as indicated:

	Per cent
Foreign matter to	0.1
Moisture to	.1
Oil to	.1
Ammonia to	.01
Free fatty acid up to 5 per cent to	.1
Free fatty acid above 5 per cent to	.5
Indexes to	.1

From these data the grade should be calculated as shown in the following examples.

EXAMPLES OF CALCULATIONS OF GRADE

The following examples illustrate the method of calculating the grade of a shipment of cottonseed from its analysis.

Example No. 1.—From the following analysis calculate the grade of the cottonseed: 18.50 per cent oil, 3.50 per cent ammonia, 1.8 per cent free fatty acids, 3 per cent foreign matter, and 12 per cent moisture.

$$4\times 18.50 = 74.0$$
$$6\times 3.50 = 21.0$$
$$\text{Plus } 5.0$$
$$100.0 \text{ quantity index.}$$

Free fatty acids, foreign matter, and moisture contents within the limits of prime quality cottonseed.

Quality index 100 per cent.

100 per cent of 100 equals grade 100.

Example No. 2.—From the following analysis calculate the grade of the cottonseed: 19.25 per cent oil, 3.70 per cent ammonia, 0.5 per cent free fatty acids, 0.5 per cent foreign matter, and 9 per cent moisture.

$$4\times 19.25 = 77.0$$
$$6\times 3.70 = 22.2$$
$$\text{Plus } 5.0$$
$$104.2 \text{ quantity index.}$$

Free fatty acids, foreign matter, and moisture contents within the limits of superior quality cottonseed.

Quality index 102 per cent.

102 per cent of 104.2 equals 106.2 or grade 106.

Example No. 3.—From the following analysis calculate the grade of the cottonseed: 22.6 per cent oil, 3.87 per cent ammonia, 2.5 per cent free fatty acids, 5.2 per cent foreign matter, and 14.6 per cent moisture.

4×22.6=90.4
6×3.87=23.2
Plus 5.0

118.6 quantity index.

Free fatty acids, foreign matter, and moisture contents within specifications of subquality cottonseed. Quality index found as follows:

Free fatty acids	2.5—1.8= 0.7
	0.7× 5 =3.5
Foreign matter	5.2— 3.0=2.2
Moisture	14.6—12.0=2.6
	8.3

100 per cent—8.3 per cent equals 91.7 per cent quality index.
91.7 per cent of 118.6 equals 108.7 or grade 109.
Example No. 4.—From the following analysis calculate the grade of the cottonseed:
16.5 per cent oil, 4.77 per cent ammonia, 1.2 per cent free fatty acids, 2.0 per cent foreign matter, and 8.0 per cent moisture.

5×16.5 =82.5
6× 4.77=28.6

111.1 minus 12=99.1 quantity index.

Free fatty acids, foreign matter, and moisture contents within the limits of prime quality cottonseed.
Quality index 100 per cent.
100 per cent of 99.1 equals grade 99.
Example No. 5.—From the following analysis calculate the grade of the cottonseed: 21.7 per cent oil, 3.85 per cent ammonia, 1.0 per cent free fatty acids, 15.2 per cent foreign matter, and 13.7 per cent moisture.

4×21.7=86.8
6×3.85=23.1
Plus 5.0

114.9 quantity index.

Foreign matter and moisture contents within the specifications of subquality cottonseed.

Foreign matter	15.2— 3.0=12.2
Moisture	13.7—12.0= 1.7
	13.9

100 per cent—13.9 per cent equals 86.1 per cent.
86.1 per cent of 114.9 equals 98.9 or grade 99.

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